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ABSTRACT

This document describes an investigation designed to examine the possibilities for using both existing and new technologies to increase and enhance public service capabilities at the University of California, Santa Barbara (UCSB) Library, and to recommend an ongoing mechanism for assessing priorities for the application of technology in the library and for monitoring technological change. The task force action plan is set forth, study methodology is described, and detailed findings and recommendations are presented in four sections, each of which is devoted to one of the following study components: (1) systems based on mainframe and minicomputer technology (online catalog, serials, acquisitions, circulation, and interlibrary loan); (2) information access; (3) storage technology; and (4) telecommunications and networking. A brief bibliography is included at the end of each section. Overall task force recommendations include: establishing an office of technology; training patrons and staff in the use of automated systems; acquiring an interlinked online system; maintaining current and future technology at a level consistent with public service demands; making "Scholars' workstations" available in the library for patron use; researching and acquiring disk technology; purchasing microcomputers for use among library personnel on a large-scale basis; and providing opportunities for library personnel to develop search aids and integration strategies for reference tools and resources. (KM)

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# UNIVERSITY OF CALIFORNIA
# SANTA BARBARA

## OMS PUBLIC SERVICES STUDY

## TECHNOLOGY TASK FORCE

## FINAL REPORT

April 1986

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TECHNOLOGY TASK FORCE

REPORT

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TECHNOLOGY TASK FORCE

EXECUTIVE SUMMARY

Significant advances in telecommunications technology over the last 40 years have made possible both digital and analog communications over a wide variety of transmissions media (e.g.,twisted pair wire, coaxial cable, optical fiber, radio, microwave, television and satellite). Various combinations of these medium have been used to create integrated telecommunications networks capable of carrying voice and visual images, as well as supporting the larger bandwidth and faster transmission speeds necessary for the transport of digitally encoded data.

At the same time advances in the design of mainframe and minicomputers have enhanced computing capabilities enormously while reducing hardware costs. For libraries this has meant that storage of large files of records has become economically feasible.

The marriage of data processing and telecommunication systems has also spawned the growth of computer-based networks. National bibliographic utilities such as OCLC and RLIN provide individual libraries access to shared remote computing facilites and to the records of a number of

at libraries for information sharing and for co-operative cataloging ventures. Through similiar computer sharing capabilities and communication links, commercial bibliographic search services, (DIALOG, BRS, etc.) offer online bibliographic access to journal literature and to other kinds of information--wire services, legal texts, statistical data etc.--to which many libraries previously had limited or no access.

Large files of data maintained by academic libraries have proven to be increasingly difficult to access and prohibitively expensive to maintain manually. Academic libraries have turned to automation of library systems to provide rapid and economic access to vast storehouses of knowledge and to meet the sophisticated needs of [illegible] research is commonly dependent on computer applications of one sort or another. Until the recent advent of turn-key systems, the difficulty for many libraries has been the incremental growth of automation which has not been even in all areas. Automation at UCSB Library is a case in point.

The present circulation system at UCSB represents the [illegible] stage in an ongoing effort to improve the accessibility of library holdings within the University community. Similar improvements in hardware and capacity are needed immediately to prevent deterioration in public service. The installation of an online interlinked system connected to

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the UCSB broadband network will satisfy the expressed needs of UCSB patrons for immediate and remote information on the circulation status of needed research materials from UCSB's collections.

Presently UCSB's Interlibrary Loan Unit uses a combination of lending and borrowing services (through OCLC & RLIN: now delivered requests between UCSB and UCLA; and manually typed ALA forms which are mailed to institutions). Linkage with MELVYL (TM), the UCSB online public catalog and circulation systems would save ILL staff from many time-consuming activities of separate file checking and physical shelf checking presently involved in ILL service. Connecting an ILL microcomputer to UCSB'S broadband network would allow ILL to receive and respond to campus ILL requests (from departments and individuals connected to the computer center), thereby decreasing the turn-around time for responding to local ILL requests while increasing UCSB satisfaction with Library services.

Technological advances in access and storage of print and non-print materials will have a positive impact on the Library's ability to cope with the ever burgeoning information explosion and the researcher's demands for access to needed materials. Currently used equipment (eg. as projectors, micro-material readers and tape recorders) will need to be kept and maintained for use with their

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associated materials as they are now the most accessible of widespread media. However, CD-ROMs, videodiscs and WORM optical storage formats are clearly superior in terms of storage quantity and rapid access. These formats are also interfaceable with computers. Optical storage has wide capabilities for storing music, text, graphics or film. The current predominance of magnetic and film media will fade as laser discs become economically feasible mediums. These new formats represent a solution to long-standing library problems of storage, preservation and quick access to library resources. Optical disc storage is also being used to bring quick, on-site, end-user searchable access to serial indexes and abstracts, and a growing number of "full-text" journal articles through systems such as Infotrac.

Other factors, including the increased demands of computer sophisticated patrons, the use of "smart" terminals, i.e. the possibility of locally owned and produced databases, will also increase the use of computer-assisted serials indexing and abstracting services. As the Library begins to provide bibliographic access to a wider range of materials, patron demands for previously little used or little known sources such as textual and numerical databases and offline machine-readable databases will grow in the next decade. Training of reference personnel in the use of database and serials services, promotion of these services to the University community, and user education in the utilization and

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manipulation of the "electronic library" will increasingly be accomplished through the use of videotaped lectures, programmed learning exercises, interactive videotext tutorials, and other computer-assisted media presentations. The integration of these services into the interlinked library automation effort is a possibility within the next ten to fifteen years.

In the past five years, in-house and commercially available systems for automation of library activities have been adopted by an increasing number of academic libraries and have been interlinked through mainframe technologies and microcomputer applications to provide access to an online public catalog, circulation, acquisitions, serials, ILL, and cataloging through a single terminal. Dial-up access via telephone or a direct connection from campus computer terminals connected to the UCSB's broadband network are feasible ways to provide remote access to the interlinked system. Although a totally interconnected network to give wide spectrum of remote information and library services through a single terminal or computer using natural language search strategies is not yet a reality for a variety of technical reasons, publicly accessible interlinked systems (and remote access to them) as well as a large number of optically stored databases of all kinds can be expected to be commonplace in the academic library within the next 10 years.

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# CHARGES

## TECHNOLOGY

The Task Force is charged to broadly examine the question of how to use both existing and new technologies to increase and enhance public service capabilities. In examining this broad field, The Task Force should focus on:

Recommendation of priorities for the application of technology and the automation of library functions and services;

Changes taking place in the world of scholarly research and communication;

The "universe of technologies" available and appropriate to the UCSB Library;

Impact on user education;

External relations required in this environment (i.e., consortial agreements, ILL policies, networking, etc.)

Technology Task Force
Action Plan
October, 1985

Task Force Charges (in priority order)

1. Recommendation of priorities for the application of technology and the automation of library functions and services.

   A. Scope and objectives
   Our objective here is to determine how (appropriate) technologies can best meet the public service needs of our patrons. Information gained from other Task Force reports will be used to help determine a final set of priorities for public services.

   A second objective is to recommend an ongoing mechanism for assessing priorities for the application of technology in the library and for monitoring technological change.

   B. Methodology
   We will draw on information generated from the Users Survey and will conduct a limited number of personal interviews with library staff and faculty. Data collected in examining priorities 2-5 may also be used.

2. The universe of technologies available and appropriate to the UCSB Library.

   A. Scope and Objectives
   Our examination of the "universe of technologies" will focus on those technologies which can be applied to public service functions of a) information access, b) information sources, and c) user support services. The "universe of technologies" is a vast, rapidly changing area. It would be impossible to predict what specific configuration of hardware, software, telecommunications systems, storage formats, etc. will be available ten years from now in such an innovative environment. What we can do is describe the types of technologies that may be available 3-5 years from now, and make recommendations on what technologies would then be available. We can also specify the public service functions an "ideal" technology will accomodate 5-10 years from now. Our consideration of these technologies will include an evaluation of current technology--what is presently available; how it is currently being used; suggestions for the optimal use of current technology; an exploration of new and developing technologies; ways in which both new and current technologies can be creatively used together; and maintenance and implementation arrangements for new technologies.

   B. Methodology
   For each of the following areas we would like to investigate 1) current technological applications 2) identify new technologies and 3) evaluate these technologies and their possible applications at

the UCSB Library in light of data from priority 1:

--In public services operations at UCSB
--In other units of the Library
--Elsewhere at UCSB
--Elsewhere in the UC system
--At other institutions

Methodologies will include:
—Literature search
--Interview with specific user groups, campus administrators, consultants.
--Visits to other facilities on and off campus

3. Changes taking place in the world of scholarly research and communications.

A. Scope and Objectives
Identify areas in which the Library can continue to aid scholars by either supplementing or tapping into the technologies which scholars are presently using and those they anticipate using. We will examine what kinds of technologies scholars are using in their research and the impact this use has on their relationship with the UCSB Library in particular, and libraries in general. How do they perceive current and future needs in light of their current and projected use of technology? How have their communication methods changed vis-a-vis each other and libraries?

B. Methodology—Same as in Priority 2 above.

4. External relations required in this environment (i.e. consortial agreements, ILL policies, networking, etc.)

A. Scope and Objectives
Examine and determine the technology necessary to support new kinds of external relations; examine what configurations these relations may take. We will examine the technologies being applied by the networks to advance the work of the network (e.g. telecommunications systems, software, etc.) to determine what impact this will have on public service functions at UCSB. We will also want to look at the kinds of external relations necessary in a new environment (e.g. vendor to library contractual arrangements, maintenance contracts, etc.).

B. Methodology—same as in Priority 2 above.

5. Impact on user education

A. Scope and Objectives
Our objectives here are to examine what new kinds of user education are possible using the new technologies at UCSB, and to explore how we can best educate users to take advantage of new technologies available in the UCSB Library.

B. Methodology—same as in Priority 2 above.

TIMELINE

October--conduct literature searches and determine interview schedules:
November--carry out site visits and conduct interviews
December--evaluate data
January--write up final report

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## METHODOLOGY

The task force used DIALOG, BRS, MELVYL (TM), Wilsonline and Infotrac literature search systems to find pertinent material from the fields of computer science, telecommunications, information science and librarianship.

Manual searches of some of the printed indexes, personal files, departmental files and Librarian's office files also turned up appropriate material.

Task force members also gathered information from contacts with administrators, faculty and other librarians.

The task force used the results of the surveys from the User Needs and Education, Organization, Coordination and Staffing, and Facilities, Space and Equipment task forces in making certain recommendations.

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## SYSTEMS BASED ON MAIN-FRAME AND MINICOMPUTER TECHNOLOGY

During the last decade there have been major advances in mainframe computer technology which have resulted in faster processing time, vastly increased storage capacity and reduction in costs for hardware and processing time. In the last five years advances in design of minicomputers has resulted in small machines able to do tasks which previously required the computing capacity of large main frame machines. In the next fifteen years we can expect the advent of relatively small computers , about the size of todays minis, which will be able to handle the massive tasks which require the use of a Cray supercomputer today. (1)

These rapid advances in computer design have been matched by breakthroughs in telecommunications technology resulting in new opportunities for library automation. The convergence of technological advances and the emergence of national standards for machine readable bibliographic records and the wide explosion of personal computer use, has led to fundamental changes in the way in which libraries are able to provide bibliographic records and access to information.

### THE ON-LINE CATALOG

Writing in 1980, Richard Boss and Deanna Marcum outlined tbe critical problems facing libraries in their attempts to make an increasing variety of materials available and to provide easy access for patrons. They pointed to the high cost of maintaining card catalogs; backlogs in cataloging and filing; the lack of bibliographic records for whole classes of material, such as government

publications, microforms and serials in card catalogs; the increasing complexity of filing rules; the inconsistencies of records which have resulted from changes in cataloging and filing rules and the imposition of local practices; the vulnerability of card files to theft, vandalism, and the ravages of time; and limited accessibility to card catalogs, which must usually be consulted in a single physical location (2).

In facing these difficulties, libraries have adapted new technologies with increasing momentum in order to keep abreast of the demand for more rapid processing of library materials, more comprehensive bibliographic control and less complex and fragmented patron access. The availability of on-line cataloging through the facilities of bibliographic utilities which adhere to national standards to provide machine readable records manipulable in a variety of ways, together with the capacity to do rapid retrospective conversion of existing manual records to machine readable format, gave impetus for the development of online public access catalogs in the late 1970's. In 1980, Boss and Marcum had not been able to identify any operating commercially available online public access catalogs, although they recorded that several were in the design or testing stage - UTLAS, CLSI, Cincinnati Electronics, and Dataphase. They also noted that several large library systems were developing in-house on line patron access systems, but none were yet in the full operating mode - NOTIS, MELVYL, ILS, CARL.

An updated Library Technology Report, published in 1984, portrayed a very different situation, recording, as it did, that 30 online access systems were now available to fill a variety of needs (3). Joseph Matthews in his Directory of Automated Systems provides a detailed report on the features of 27 online patron access systems available in 1985 (4). During the same year an inventory of automated systems used by the major academic research

libraries in the nation revealed that at least 29 were using some form of online system for patron access to bibliographic records (5). The rapid adoption by academic libraries of the new automated systems is not surprising, since the problems which Boss described are particularly burdensome to large academic libraries, which must support immense collections of complex material and serve an increasingly sophisticated clientele.

ONLINE CATALOG - LOCAL CONCERNS.

UCSB is facing concerns about the cost of filing and maintaining the card catalog, the problem of providing remote access to library bibliographic records campus wide, the need to make a variety of access points to bibliographic records available, and the problem of providing access to a variety of material not currently represented in the card catalog. The online catalog appears to offer the solution to these problems. At UCSB, however, an expectation that a fully developed Melvyl (TM) system would meet our needs for an in-house online catalog has been replaced by the realization that Santa Barbara needs access to records not included in the Melvyl (TM) system and that we will have to provide an interlinked system providing patron accesss to in-process records, brief cataloged collections and full bibliographic records, as well as acquisitions, circulation and serials receipt records (Memorandum to the Vice Chancellor from the University Librarian, December 1984). Patrons and staff alike are demanding more effective processing and public service tools, and it is clear that the implementation of more automated systems is necesssary to meet these needs. The recently completed UCSB user surveys indicate very clearly that patrons are anxious to have remote access to catalog and circulation records, and that many of them already have access to microcomputers which could interface with library systems through the campus broad band network.

ONLINE CATALOG - CURRENT STATUS.

The Library currently uses the Melvyl online union catalog as the only on-line patron access to the library's cataloged holdings. Currently, this system does not allow the inclusion of non-monographic formats, in-process material, or brief listed material. Remote access to the records mounted is limited by the number of ports to the Melvyl system which have been assigned to the Santa Barbara campus. An Automation Committee has been appointed to seek an online public access catalog which will interlink with processing activities to provide a flexible and cohesive access system to the library's collections. In order to achieve this the Library will have to carry out retrospective conversion of manually produced records to machine readable format, and will have to install interlinked automated technical processing systems.

At Santa Barbara retrospective conversion is already underway. A large conversion project is being carried out by the Cataloging Department which is estimated to result in 70% of the material represented in the Card Catalog being converted to machine readable format by 1987. Cataloging itself is already done on-line through the RLIN utility and it is not anticipated that there will be any problem in interlinking the cataoging function with the on-line catalog.

In other areas interlinking will require the installation of completely new automated systems. It will be necessary to automate acquisitions and serials functions so that those records will be easily accessible through the on-line catalog, and to provide automated access to circulation records, either through the existing system, or through a new one.

**RECOMMENDATIONS**

The Library should move as quickly as is judicious to provide the UCSB Library with an online public access catalog which will provide patrons with an

easy to use vehicle for identifying material in the Library's collections, cataloged or not. The system should have the following capabilities:

a) The capacity to store records for a very large data base, at least four times larger than our current holdings would require. It must have the capability of accepting records for material in different formats, and with differing levels of bibliographic description. Manipulation of these records in a variety of ways for public service and management information must be supported.

b). A user interface module which would provide easy access to patrons having different levels of sophistication in accessing library materials.

c). The provision of a variety of access points for searching purposes designed to provide a subject approach which would overcome the limitations of Library of Congress subject headings, and to provide author and title approaches which would obviate the need for a patron to know the exact author and title of needed material. Call number access, ISBN, ISSN, and RLIN number access is also needed.

d). Fast response time.

e). Security of records.

f). The capacity to support a large number of terminals, including remote access terminals.

g). Must have the capacity of interlinking with acquisitions, cataloging, circulation and serials systems to capture records and provide a patron with immediate holdings and location information.

h). High reliability, - low down time. Capability for continuous back-up memory so that no data is lost.

i). Back-up system providing access for down time periods.

SERIALS SYSTEMS.

The development of automated systems for the acquisitions and processing of serials has followed the pattern of development for the Online Catalog. Although articles about the automation of serials have appeared in the professional literature for many years, few operating systems were recorded until relatively recently. Reynolds records that the University of Texas was using an IBM punched card system for serials acquisitions purposesin 1946, and that in the 1950's the Massachusett's Institute of Technology had begun to utilize punched card technology for the the production of serials holdings lists. He noted the reason why the automation of check-in records lagged behind these early experiments " Of all technical library procedures, serials check-in has been one of the most difficult to automate. The unpredictability with which even scheduled issues arrive, the diabolically ingenious frequency patterns of many journals issued on a "regular" basis, the annoying proportion of titles that do not even claim to be issued on a regular basis, and misnumberings and other discrepancies all conspire to make serials check-in difficult to say the least. Automation operates on a principle of controlled, or at least defined, options and the issuance of serials has always had little respect for such requirements". (6) The University of California, San Diego was a pioneer in the development of a batch system for serials check-in, and claiming, starting its project in 1961 and developing a very sophisticated system by the end of that decade. On-line processing of serials was an inevitable next stage in development, in order to achieve the record currency important for serials processing and service work. Another University of California Library, the Biomedical Library at UCLA, produced one of the earliest on-line serials processing systems in the early 1970's. Despite these early beginnings, few serials systems were available commercially until the 1980's, but by 1985 McQueen and Boss were reporting that " a library seeking an automated serials

control system to mount on its own computer has, in 1985, 29 different options marketed by 33 vendors. Seven vendors offer systems based on remote processors. Some offer multiple systems, and some systems are marketed by more than one vendor. Another 21 organizations were developing, or planning, commercial serials control products, with expected completion dates from mid-1985 to 1987 or later".(7) The Automation Inventory of Research Libraries recorded that 20 research libraries were using some form of serials automation in 1985.(8) Clearly, technological advancements had paved the way for a rapid move from famine to feast, and early reservations about the practicability of automating serials systems had been overcome by 1985. It appears that the time is now ripe for libraries to move into the automation of serials acquisitions and processing.

SERIALS CONTROL - LOCAL CONCERNS.

A need for in-process tracking of serials orders and receipts, accessible from remote stations, has become increasingly apparent as the size of the Library's serials holdings has grown, and there is an increasing demand for immediate information about this time-value material. Allison claims that there is "universal acceptance of the facts that serials constitute the single most important avenue for communication of research data; that serial costs represent the largest component of library budgets; and that these costs are growing on absolute and relative scales". At present the only remote access to UCSB serials receiving and holdings records is the Serials List, which is produced at four monthly intervals and provides consolidated holdings, not issue specific data. Although an outstanding example of its kind, the Serials List no longer satisfies all the demands of library patrons who are increasingly becoming accustomed to rapid online access to a wide variety of data required

for their research and studies, often from their own computer terminals. Furthermore, there is now sufficient data to suggest that the new generation of serials acquisitions and control systems offer the means of providing faster and more accurate processing of material; more comprehensive control of claiming activities; better management information for administrative and collection development purposes; and a vehicle for monitoring of vendor performance.

## RECOMMENDATIONS

The UCSB Library should move with all speed to install an automated serials system which would interlink with the online catalog system to provide remote access to a variety of serials records for the use of patrons and staff members. The system must:

1. Interlink easily with the online catalog so that access is transparent.
2. Have the capacity to accomodate full records for at least three times the number of serial titles currently held by the Library.
3. Provide friendly interface screens.
4. Support the full range of serials processing and acquisitions functions appropriate to the type of serials collected by large research libraries.
5. Provide a wide variety of statistical reports for management.
6. Have the capacity to support production of a serials holdings list.
7. Have remote access capability for such records as receipt status, binding status, on order status, claiming status.
8. Have a variety of access points including title, corporate author, call number, ISSN number , title keyword search, alternative title search.

ACQUISITIONS.

Interestingly, the automation of library acquisitions functions developed more rapidly than any other library application, with the exception of library circulation. Boss reports that hundreds of libraries automated their acquisitions operations between the 1950s and the 1970s which were the early years of library automation. Many of the early systems were developed in house, but by 1969 commercial vendors were offering acquisitions systems, most of them batch process systems. By late 1981 he notes that one out of five libraries with annual acquisitions budgets of more than $200,000 were using an automated acquisitions system.(8). Matthews identified more than 20 acquisitions systems commercially available in 1985 and others in various stages of development. (9). Research libraries are increasingly adopting automated acquisitions systems; the Automation Inventory of Research Libraries shows that 47 had operating systems in 1985 (10).

It has become increasingly clear that automation can reduce the number of paper files normally maintained in labor intensive manual systems. Furthermore, automation of ordering functions can readily provide management and collection development statistical data, which is otherwise prohibitively expensive to obtain. When acquisitions systems are interlinked to one of the major bibliographic utilities ready transfer of information from the bibliographic data base to the acquisitions data base is possible, effectively speeding the ordering process, and facilitating the identification of duplicate orders. When acquisitions systems are linked to online catalogs, patrons and staff alike have instant access to records showing that the material is on order, newly received, or in the cataloging process. It appears that effective software is now available for acquisitions functions combined with book fund accounting systems, and that there is a major move towards library automation in this area.

LOCAL CONCERNS.

At present, although Santa Barbara has an automated book fund accounting system, acquisitions functions are still carried out manually. Pre-order searching is done via bibliographic utility, but no automated system exists for capturing bibliographic records found on-line. No public access is available to on-order records. Although there is access to records for some material received but not cataloged, the only option is to search by title. Service librarians have expressed a need for remote access to an in-process tracking system so that they can readily identify material ordered, or received but not yet on the shelves. This cannot be readily provided in a manual system. Some interest has been expressed in providing for remote input by computer of requests to order material, thereby speeding up processing and reducing the amount of paper work required. In order to serve these needs, automation of acquisitions functions is required.

RECOMMENDATIONS.

The Library should take immediate steps to provide for the automation of acquisitions functions, and book fund accounting. Preferably these two functions should be in a single system in order to avoid more than one keying of information. The acquisitions system should be linked to the online catalog and the bibliographic utility, so that in-process records may be tracked at remote sites, and so that bibliographic information identified during pre-order search, can be automatically captured for the processing records.

The system must have the following features:

1. Must link with the online catalog, the bibliographic utility and other processing systems so that as much data as possible is available for capture, and so that remote access of processing records will be easy.

2. Must be capable of supporting a large number of active orders, with complex entries.
3. Must provide clear user screens providing easy access to information.
4. Must provide a variety of statistical reports for management.
5. Must provide a variety of access points for searching.
6. Must be able to provide a variety of reports and form letters.
7. Must make provisions for book fund accounting.

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9. Ibid.

10. Ibid.

## Circulation systems

### SUMMARY STATEMENT

The present circulation system represents the latest stage in an ongoing effort to improve the accessibility of library holdings within the University community. Although it meets current needs and is a vast improvement over previous manual operations, the increase in down time, due to the general deterioration of the hardware, has reduced the quality of service. Updating the Central Processing Unit (CPU), supporting hardware and software, would restore the system and make it possible, within the next two to five years, for the library to initiate an expanded program. With improved capacity, such a system should pave the way for the gradual implementation of an interlinked computer system, which would meet the projected needs of the circulation department, provide on-line linkage throughout the library, and ultimately, lead to the establishment of a network of scholar workstations.

### CURRENT CIRCULATION SYSTEM

The operative system supports all of the basic circulation functions: checkout, checkin, renewals, recalls,

bills, snags and daily patron notices, etc., as well as, statistical information for the department. In addition, the CPU is linked with the Registrar's Office, campus Billing Office, and Cataloging Department through the use of a tape loading and downloading system. The main frame also supports a completely computerized Reserve System. Through it, reserve materials are circulated in two hour or one day increments with an automatic cut-over for overnight loans. To assist students, book lists and printouts by class are produced, as required, throughout the quarter.

Although the current circulation system is adequate, the hardware is in need of updating and/or replacement. Frequent break downs and occasional head crashes result in the loss of records. This, in turn, creates billing, inventory, and search problems and reduces patron confidence in the system. The above shortcomings, however, reflect the unreliable condition of the hardware and have little bearing on the effectiveness of existing programs.

## TWO TO FIVE YEAR PROJECTION

Beyond the expansion of existing applications and improved maintenance, an upgraded circulation system should feature an "interlinked library system ... with the ability to search a remote data base for bibliographic records and transfer them to the local system." ( See, Library Technology Reports, March/April 1982, Vol. 18, Number 2, p.

131) It is envisioned that this would greatly improve the access and response time. But to implement an interlinked system, the CPU and hardware must possess adequate power and expansion capabilities. Most libraries, with systems linking acquisitions, serials control, circulation, reserve, on-line catalog, and other functions, provide in-house terminals with the capacity to reflect the location and availability of library material. (Ibid, p. 131)

Ideally, such a system should possess a real-time backup or a mirroring process to store records. In both cases, if one disc fails all information is still accessible and there is no loss of data. But a mirroring system provides an additional benefit. By placing the head of one disc at the inner track, and the other disc head at the outer track, the time required by the heads to access data is reduced by one half.( See, Library High Tech News, December 1985, Issue No. 22, p. 7) The CPU and hardware should be 99 percent reliable; but, in the case of failure, it should have a computerized backup system and telephone requests for assistance with problems should be answered within two hours.

For library materials to be completely accessible through a computer search, the entire collection must be either in our on-line catalog or in the circulation system's records. If the library purchases an interlinked system, the problem of determining the location of library material at any specific time will be solved. When implementing such

a system, material will be entered into the computer as soon as it is ordered. The possibility of tracking its progress through the acquisition and cataloging process, until it reaches the main library stacks or a special location, will be available through a computer inquiry. But, if the library intends to continue with the current system, the material must be input into the circulation system and assigned a zebra label. Without this step, a portion of the present holdings will remain unaccessible through a circulation computer search.

## FIVE TO TEN YEAR PROJECTION

In assessing the impact of the information revolution, F. W. Lancaster predicts "that electronic communication will continue to substitute for other forms", and that, in time, "electronic publishing will largely replace print-on-paper publishing." The end result of which, as he points out, will be that "libraries as we know them will become obsolete." From his perspective, "the only uncertainty relates to the pace of change." (See, F. W. Lancaster, Libraries and Librarians in an Age of Electronics, p. 109) Although it is impossible to foresee all the ramifications or set an accurate timetable, it seems certain that circulation systems will play a major role in this transformation. Instead of being limited to a purely record keeping function, they will become an integral element in

library management. Within a ten year period, advanced on-line systems should enable patrons to access library material through a network of scholar workstations.

Once they become operative, the need to visit libraries will decline. As a precursor to such a system, the library's document-delivery service could be viewed as the initial step in the process of acclimating patrons to the circulation system of the future. Currently directed by a desk supervisor, this manual system will eventually give way to computerized procedures. Through the use of remote terminals, scholars will gain direct access to library material. Located in homes and offices, these workstations will not only constitute a patron's primary contact with the library, but they will also form the core of the circulation system.

Initially, the library will house a majority of the workstations; but, as costs decline, they will also be placed in labs, dorms, and within departments throughout the University. Although the size and cost of a terminal remains a matter of speculation, the type of functions it should perform has been fairly well established. Most experts agree that a standard workstation will feature: a screen with graphic display capabilities, a keyboard for word processing, a videophone display, and facilities for optical sacanning and voice input, as well as, a printer. Through it, a patron could access library material, display it, compile notes, create files, and, if necessary,

photocopy parts of the text being researched. Moreover, bibliographic searches could be made. This would allow browsing and enable users to view the latest acquisitions.

## INTERLIBRARY LOANS

In the last 5 years, Interlibrary Loan lending has doubled in growth. The 450 requests have now grown to over 1000 per month. This increase is due to the use of OCLC. The borrowing rate has remained relatively the same with the exception of peak periods when 1200 to 1300 requests are submitted. With the increase in enrollment, this is expected to increase also. With the use of both OCLC and RLIN, the lending will also increase again.

The present Interlibrary Loan system now consists of 4 different mechanisms for ordering I.L.L. material: TWX (I.L.L. requests are sent to UCLA via teletype); through the national utilities (OCLC; RLIN) and through manually typed ALA forms.

The search procedure through the OCLC terminal includes entering up to 5 locations which will be queried for a response. This "lender string" can be called up at any time to find out the status of a request. If the request is not filled at the end of the lender string, the request will be entered into the " message waiting" file as an unfilled request. Each unfilled request is then cancelled to remove it from the message waiting file and the process can begin again if there are other locations in the OCLC system. If there is no bibliographic record a blank ALA format can be used even though not verified as a bibliographic record on OCLC. Should there be no further locations the request will be re-verified in RLIN and NUC (National Union

Catalog) and the request can be sent on the typed ALA form via US mail to other libraries.
RLIN requests are handled the same way as OCLC but with 6 locations in the lender string. RLIN is a utility of the Research Libraries Group. Interlibrary loan requests are sent to participating libraries.

TWX requests are sent via teletype terminal to UCLA URL library along with branch library requests. The branch library requests are forwarded by the UCLA ILL staff to the branch library on the same day as received. Rush requests can be handled on an individual basis and usually can be obtained within 24 hours. Less than 1% of total monthly requests submitted are rush requests.

Teletypewriter Exchange Service often called TWX service, provides two-way printed communications between two or more subscribers' machines temporarily connected by lines and switching equipment. TWX service is provided in the United Sates and Canada. Messages are sent and received by teletypewriters at speeds of 60 or 100 words per minute (wpm) in the United States and 100 wpm in Canada.

Station equipment for TWX service consists of a teletypewriter, a data set, and a dial. The 60 wpm machines use the 5 unit Murray code to represent letters and numbers by direct-current pulses. The 100-wpm machines use the 8

unit ASCII code. The data set, which serves as an interface between the teletypewriter and the subscriber's line converts the direct-current pulses to tones suitable for transmission over a switched network. The dial permits access to the switched network from the subscriber's station, and it provides the signaling and supervisory functions to establish a station-to-station connection.

A subscriber using a 60 wpm machine is served from a telephone central office, and the message is switched over the telephone network in a manner similiar to that for a telephone call. A subscriber using a 100 wpm machine is served from a specially equipped central office, and the message is switched over a separate TWX network. Communication between 60 wpm and 100 wpm machines is possible by means of speed and code conversion units in telephone company offices. The TWX service now is maintained and operated by Western Union.

## FUTURE RECOMMENDATIONS

The Library should connect to the campus local area network where the campus computer system would enable patrons to connect to the ILL subsystem of the library's interlinked system and thus make direct ILL requests. Document delivery would be offered from ILL. Interlibrary loan depends a lot

on what the rest of the library has in the way of new technology for bibliographic searching and online catalog.

STORAGE MATERIAL: A direct link or access from ILL to the storage facility at UCLA is recommended for fast delivery.

If lending continues through OCLC the purchase of an OCLC Micro-Enhancer is recommended. The Micro Enhancer (ME) is an OCLC software package providing microcomputer access to the OCLC Online System. In addition to supporting microcomputer use of all OCLC subsystems, it has a number of specific features which facilitate and streamline use of the ILL subsystem. These features are designed to reduce the amount of staff and terminal time required to perform record keeping functions in the ILL Subsystem. The ME utilizes the sophisticated capabilities of microcomputers to decrease human interaction with the online system and to increase the efficiency of ILL processing. The ME permits Ill Subsystem participants to designate while offline the ILL record numbers for subsequent updating online. These records are automatically batch processed by the microcomputer through the OCLC ILL subsystem. The ME is a new approach to OCLC Subsystem development. Installing enhancements in microcomputers as well as in the Online System expands OCLC's ability to meet a variety of library needs.

A MELVYL (TM) terminal is recommended for ILL use to save time in verifying requests in the UC system. Also an ILL subset of an interlinked online system with circulation, acquisitions, serials etc. is recommended.

ELECTRONIC MAIL

It is defined as "the electronic transmission of messages, text and graphics between two or more individuals." In terms of this definition, electronic mail is a pretty broad topic, encompassing TWX, telex, facsimile, etc.
Electronic mail provides rapid transmission of messages between computer terminals. Users regard it as superior to regular postal and telephone services because unlike regular mail, electronic mail is instantaneous. A message can be compared, edited and transmitted in minutes. Common library applications include communication among members of committees, intra-organzational communication among dispersed locations, reference query referrals from one library to another, announcements of meetings and transmission of interlibrary loan requests.

Several library groups have installed electronic mail systems. The largest effort to date is that of the California Library Authority for Systems and Services (CLASS) which has negotiated a group rate for use of the telenet ONTYME Electronic Mail System. In an electronic

communication network such as OnTyme, each user is assigned a private mailbox within the central or "host" computer. Users reach their mailbox via telephone through the international TYMNET network. Once logged on, users can read messages from other users,create and send messages, or review stored files. Messages and files can be sent at any time; mail is stored until the receiver logs on and requests his mail. As a result, time zones and busy signals are no longer a barrier to communication, and all transmission costs are free of long distance charges. OnTyme's commands are easy to learn and require little training. OnTyme is significantly less expensive than TWX, more reliable than the postal service, and as fast and convenient as a telephone call.

LIbraries which use Electronic Mail are generally happy with the technology. In some Interlibrary Loan applications its use has resulted in staff and equipment savings. Both CRT or printing type computer terminals can be used to access ONTyme II. A combination of CRT and printer is recommended.

URL is presently evaluating electronic mail systems to acquire when their TWX breaks down. They do not intend to repair it and will go onto the new E-mail system when such breakdown occurs. They would prefer to get a Hayes Smartmodem like that used by Biomed, but otherwise would use

the CLASS Messenger system. An electronic mail system should be given first priority for Interlibrary Loan.

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## Information Access

**Printed indexes, bibliographies, and catalogs.** Over the next ten years, the future availability of these printed materials will undoubtedly not change to any large degree. Companies that are currently in the business of publishing these works will not be likely to discontinue completely hardcopy versions of these sources in favor of electronic access devices.[1]

What is likely to occur is for this type of searching to be a less desirable alternative to patrons who have become more and more acquainted with electronic means of bibliographic searching. In many instances hardcopy indexing will continue to be the cost effective means of conducting certain short searches, but in other circumstances the use of electronic media will be more effective.[2] (If patrons are charged for the use of a computer for searching and do not have to pay for the use of hardcopy indexes, they may opt to use the less expensive means of searching.)

**Online Bibliographic Searching.** Defined This form of searching consists primarily of using a terminal to access bibliographic citations from an indexing data base. It is designed to provide access to literature; however, it does not provide the literature or information itself. It can be contrasted with numeric and textual data base searching which answers questions by supplying numbers or textual information. It often has the advantage of allowing the searcher to cover many years of an index in one search and to combine the exact indexing terms needed to find the desired bibliographic entries.

Current Situation. Currently, the Library conducts searches for University community patrons on a cost recovery of computer expenses basis for long searches and on a gratis basis for short reference questions. The policy statement under which these searches are conducted is currently under review and may shortly be revised.

The Library has trained librarians in each of the main service points who conduct searches, usually in their areas of specialization, on the major commercial data bases. Most searching is done in the second floor online room on older terminals which are not capable of downloading information from a search (i.e. "dumb terminals"). With the recent addition of a smartmodem for the IBM-PC in Government Publications, the Library is beginning to take advantage of the speed and convenience of using personal computers as search terminals. Among the major systems accessed for bibliographic searching are BRS, CASONLINE, DIALOG, NLM, RLIN,



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and Wilsonline. (Many of the indexes found online have hard copy counterparts such as Social Science Citation Index, Readers Guide to Periodical Literature, PAIS Index and others.) The Library executed searches that amounted to $23,464.11 during the 1984/85 fiscal year, which represented a 119% increase over the previous five year period. Of this total amount, the Library paid for $15,434.19, and patrons funded $8,035.92.[3] Overall, however, this amount of searching represents a very small percentage of the total index consulting done in the library by patrons and staff: most searches are still done in printed or microform indexes.

Technology future: In the period from five to ten years from now, significant changes will be occurring in this type of access to information. One of the major changes will be the general accessibility of online indexes. Most all serials indexes that are available today in hardcopy will be available online. As indexing companies have made more use of computers to create paper indexes, it is not unreasonable to expect that online capabilities will be a natural byproduct of this process. If one projects the increase in the number of online systems that have been added in recent years into the future, it is also clear that there will be a continuing growth trend.[4]

Patron expectations. Patron expectations will also be greatly altered during this ten year period. With the automation of functions such as the searching of the card catalog through systems such as MELVYL and the availability for general patron use of such systems as InfoTrac, library users will be likely to expect similar technological advances in bibliographic searching of serials and other publication forms that have in the past been confined to hardcopy indexing. Also, the increase in inexpensive end user searching services such as DIALOG's Knowledge Index and BRS After Dark may increase patrons' demands for similar services to be provided by their reseach libraries on a free or low cost basis. Students who have been exposed to online searching in classes may also increase the demand.

Costs. The cost of searching is also expected to change. Most forecasts in this area predict decreases in both the hardware used to conduct online searching and some of the costs associated with the actual searching. The price of smartmodems and the PCs used with them are continuing to decrease as competition in the market place is helping to drive prices down. Telecommunications cost are expected to

However, the University may be in a position to offer substantially less expensive means of communication through a



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proposed system of its own ground and satellite links. In addition, the charges made by online services such as DIALOG or BRS are expected , if they follow past tendencies, to continue upward even though new vendors such as Wilson are offering competitive access to their products.5

The availability of new and more powerful hardware and software should also help to decrease the costs of searching and alter the use of online services. Combining more powerful microcomputers with new software packages already allows searchers to create their search strategy in advance of their logging onto the online system and then allows information gained during the search to be downloaded for later review, consequently lowering the cost of online access. This practice will only continue to increase over the next decade.

Another possibility over the upcoming decade will be the acquisition and maintenance of indexing information that is now only available through vendors such as DIALOG and BRS. It is conceivable that the University of California would find it more economical to purchase indexing tapes or disks directly from index publishers and bypass the need to access them through vendors. Information access to these tapes could be provided to individual campuses through a network such as MELVYL or distributed to each campus for inhouse processing on powerful mini-computers. The ability to perform such local processing will be dependent to a large extent on the increased power of the hardware used to run the programs, particularly systems that combine the speed of the mini or micro-computer with the huge read only storage potential of laser disk technology as found in CD ROMS. With the increased availability of systems that wed the use of computers with optical disks, localized information systems could well become more practical and cost efficient. This expectation for affordable hardware is not unreasonable. Pete Carey has indicated recently that there are forecasts for a microcomputer unit with "a central processor handling true 32-bit instructions (compared to today's 8- or 16 bit machines, such as Apples or IBMs) and operating at a speed of 10 million instructions per second (MIPs); 4 megabytes of RAM; 2-gigabyte (2-billion byte) optical disk; voice input; mobile citizen's band/satellite terminal; and equipped with cable-TV connections--for the price of $10,000 by 1990 and $5000 by 1995."[6] Such a machine could provide tremendously fast bibliographic access with a relatively small investment in hardware. The success of such a system would be dependent on access to relatively inexpensive optical disks produced and distributed by system-wide UC or commerical vendors. Experiences that are now taking place with InfoTrac should be monitored closely to determine future applicability of such systems.

**Information Sources**



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**Non-bibliographic online databases. Defined**: This type of searching differs from bibliographic searching in that it provides numerical or textual answers to inquiries rather than a citation to another source on the subject. Printed versions of such databases would include directories, encyclopedias, statistical abstracts, and other reference works as well as the full text of material found in monographs and serials. Vendors such as DIALOG and BRS provide access to electronic formats of some of the reference works owned by the library in hardcopy. DIALOG for instance offers such reference works as the Academic American Encyclopedia, Electric Yellow Pages, Ulrich's International Periodicals Directory , and the Encyclopedia of Associations online through its service. Also, publishers such as West's and Mead Corporation provide computer access to legal publications through Westlaw and Lexis. Business information companies such as Predicast are providing statistical information on economic and financial trends.

**CURRENT SITUATION IN THE LIBRARY**: Currently the library does very little searching on these types of databases even though a number of them are currently available through both publishers and vendors. Interviews with searchers in both [illegible] and the Reference Department indicates that less that 10% (and probably fewer than 5%) of all online searches are on these types of databases. The searchers questioned listed the following major obstacles to the use of this information format: lack of conveniently located terminals, the expense of searching, the greater speed of manually finding the information, and a general lack of experience and training with this type of searching.

**TECHNOLOGY FUTURE**: From all indications the amount and variety of information available in this format will continue to expand at an accelerated rate over the next decade. With much of the information in this format available in non-library settings such as business offices and homes, producers of this type of information have a large incentive for supplying new products for a growing market. Suppliers realize that there is a large market of end users in both the home and office and that many of the start up costs associated with searching (micro-computers, modems, etc.) have been dropping. As the use of computer typesetting has grown, it has also produced a ready made source of information for these types of databases. The continued development of optical scanners should allow the conversion of information not already in electronic format to be easily and inexpensively converted.[7]

**Patron expectations.** As with the online bibliographic area, it is expected that patrons who, according to recent user surveys conducted by the User Task Force, are becoming more acquainted with information in electronic format, will anticipate the availability of this type of information in



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their academic research library and become more comfortable with this format in the future.

**Offline Machine-Readable Information. (Computer tapes) Defined.** This category is made up of information that is available on magnetic tape or other computerized storage mechanisms. These records are often the result of research by individual researchers or groups of researchers and often are not intended for wide distribution. However, in other instances, the data may also be collected by a large institution, such as the U.S. Census Bureau, and achieve much broader circulation. The information stored in this type of file is accessible only through the use of technical documentation prepared by the compiler of the data detailing how the records are arranged within the file. Also, an access program is used to pull out the individual records in the file. Without the technical documentation and the access program, it is virtually impossible to obtain the information from machine-readable data files.[8] The main advantage of information in this format is that it can often be manipulated through the use of special software programs without the need to re-enter the data.

This source of information differs from online numeric and textual data bases in that it is not easily accessible from a remote terminal. While online data bases usually have a standardized and well documented protocol for gaining access to the information stored in its files, machine-readable files are normally used at a computer center on a main frame computer with the assistance of personnel experienced in using the software required to display the data. Even widely distributed tape data such as the products of the Census Bureau require specialized training and frequent use by the user before they can be effectively used.

**Current Usage.** The Library has collected very few machine readable data files. The Government Publications Department did own several data tapes from the 1970 Census of Population; however, without personnel trained and working with the data on a frequent basis, it was decided to transfer this material to one of the centers on campus that has a greater familiarity with using this type of information, the POLIS Lab.

Along with the POLIS Lib, the Computer Center is the another repository of machine readable material on campus. At both locations there are trained staff members to help run the programs and collections of technical documentation to guide the user in determining the contents and organization of the files. Some of the material stored in these centers are private research files which are not accessible to the general public, while others are available for general use. Included in the general use category are files available from sources such as the State Data Program at U.C. Berkeley and the Interuniversity Consortium for Political and Social Research

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(ICPSR) at Ann Arbor.

While the Library has printed directories that list some of the more widely available machine readable data bases, it does not have holdings for the files available on campus. Patrons using the main card catalog or serials list do not have bibliographic access to the machine readable files owned by the campus. As a result few if any patrons are referred from the Library to other sources of available information on campus. Users surveys recently conducted by the Library also show that few patrons are aware of the existence of such data files.9

**FUTURE TRENDS**: From all indications, machine readable data bases will continue to grow in numbers over the next decade. The computer has become and will continue to be a major companion for scholars in the social sciences, humanities and arts as well as the sciences. A byproduct of this companionship will be the growth of information that is available only in machine readable form or which will be most efficiently used in that format. As this source of information becomes more recognized as a valuable research tool, scholars will increase their demands for including, at the minimum, bibliographic access to the data and, at the maximum, including such information as part of library holdings. To what degree libraries should be involved with machine readable data will also continue to be source of major debate throughout this period.[10]

**USER EDUCATION:**

1.— **General Orientations**: The Library currently conducts a number of general orientations on library services for various categories of patrons. General orientations conducted by the Library for incoming Freshmen, some English 1A classes, EOP students, and other such large groups often combine a short videotape or slide presentation on the services offered by the organization with a walking tour. The video used in this presentation is currently being remade. In addition, the Library provides handout sheets or a tape recorded self-paced tour that can be used for self guided tours.

Technology could play a larger role in orientation programs by providing a relatively inexpensive means of informing individual patrons about services offered by the Library. Combining a personal computer with a laser disk could provide for an interactive learning experience for patrons where they ask about a particular information need and the television monitor provides specifics on how and where to obtain the needed information. The use of

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programmed learning might also provide for another type of individual instruction.

**2. Classroom Presentations:** Many of the subject specialists in the library visit classrooms or lecture to course members in the Library. These presentations are usually designed to assist the student in understanding the research possibilities for a particular course assignment. The size of the class can vary from several students to hundreds of pupils. During these presentations the amount of technology employed varies from the use of overhead projectors to video presentations produced by the Kerr Learning Resources Department. The individual subject specialist choses what, if any, is the appropriate form of a-v material to use in his or her presentation.

The production of a well done video can be quite expensive both in terms of time and money. This cost can only be justified when it will be viewed by large numbers of patrons over an extended period. Video is best suited for large classes that repeat the same library assignments year after year. Besides allowing for an intimate look at material under discussion, the use of video can allow students who have missed the class presentation or who wish to review what they have already seen to borrow a copy of the tape from the Reserve Book Service to view on the Library's VCR.

In addition to the use of video, it might also be practical to design programmed learning modules for large classes. Such programs would provide a tutorial on using specific library materials and then indicate what material needs to be reviewed by quizzing the student on the use of the material covered in the tutorial. Such a program would be dependent upon the students acquiring access to adequate numbers of terminals either connected to the mainframe or to a library-based computer. Or the Library could maintain such programs on diskettes that are checked out to the student for home use or on Library provided personal computers.

**3. Library Courses:** A number of courses are offered in research that are taught by Library personnel. Two general introductions to library research, Interdisciplinary Studies 1 and 100, are taught primarily by members of the Reference Department. The IS 1 class consists mostly of an introductory presentation and then the use of a self-paced workbook to familiarize the student with library services and techniques. IS 100 involves classroom lectures and requires the compilation of an extensive bibliography on a subject of the student's choice. Computer graded exams are used at the conclusion of each course. In the IS 100 class, some a-v materials are used in the lectures.

Courses have also been taught in subject areas such as Black Studies, Chemistry, Chicano Studies, Political Science, and Music. While taught by librarians, the



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courses in this category have been conducted through established academic departments. These classes have made use of slides, overhead transparancies, and videotapes as the individual instructors have deemed necessary. The Chemistry and Political Science courses have introduced students to online searching techniques as well as providing instruction on the use of MELVYL. This computer related instruction has been conducted on the Library's large screen monitor using a dial up system, which often is subject to poor telecommunications or having the mainframe computer go down. This problem can be circumvented in the future to a certain extent by video taping successful searches ahead of time and using them to demonstrate the desired features. Substituting "canned presentations" for live ones may prove to be more efficient, particularly if the Library can use inexpensive video equipment to record its own demonstration tapes. Instructors of these courses may also find that the use of computer assisted program modules as described above could help provide hands on experience. As more students acquire or have access to personal computers with modems, they could do such exercises from remote locations on the campus computer or one owned by the Library via a telephone hookup, or they could check out diskettes for working at home or at a microcomputer lab..

4. **Individual instruction** Currently the reference staff in each of the Library's service departments attempt not only to help patrons locate their information but also to educate them on the use of library tools so that they might be more self-sufficient in the future. This service function might also be enhanced by the use of technology that should be quite common over the next decade. Machines that combine microcomputers with voice recognition capabilities and laser disk optical systems can provide tutorial assistance on numerous levels of sophistication.

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## STORAGE TECHNOLOGY

Information storage and retrieval are the primary purposes of libraries. In the past, this has meant a multitude of books and files and a staff of librarians to assist patrons with the maze of offerings. As our society grows geographically denser, with greater demands in terms of speed and quantity of access to information, technology is rapidly rising to the occasion. A future scenario might have a student in the library, working at a microcomputer work station. She types in a keyword and in seconds thirty references appear on the screen. The articles are also available to her in seconds. An encyclopedia and several other reference volumes are cross-indexed and contained in one CD-ROM disk which she is using at the local library. How will this library be different from the traditional concept as alluded to above?

Most likely, the purposes will remain the same and the methods will change fairly drastically. It is evident that computers are playing a rapidly burgeoning role in the area of information storage and access. Tremendous amounts of digital information can be stored on minute chips and in various other accessible formats such as magnetic disks. Two more recently developed formats are the CD-ROM and the laser videodisc. Through initial programming, these formats are created for massive storage and very rapid access. These

and their players will probably be standard equipment in libraries of the future.

Both the laser videodisc and the CD-ROM are optical disk formats. Their metal and plastic foundation make them extremely durable, with more plastic protecting the recorded layer. As they are read by a low power laser, there is no physical contact, no wear from use, and the potential of damage from handling is also minimal. There is also no concern about accidental erasure as exists with any magnetic format. The interfacing of these disks with computers, though not yet standardized, is already functioning in several exciting capacities. Interactive services which allow bibliographic searches or even browsing through film clips from the 1920's are in use today.

VIDEODISC

The videodisc has taken many forms since its early development in 1972. One kind of disc was read by a stylus, similar to a phono stylus, and so physical wear remained a problem. Most likely the optical laser disc will survive as the most practical format. At this point, the only unknown factor is the life expectancy of the players themselves, and the lasers contained within. The optical videodisc is an established entertainment medium, used for

movies and rock music videos, but videotape is preferred by consumers as it is also a recording medium. Videodiscs are produced from videotape, hence there is little difference in visual quality, but though they are not recording media, they are produced for rapid access and interface with computers. Therein lies the tremendous strength as an educational and research tool. One twelve-inch disc has a capacity for a minimum of 50,000 separate images and a large amount of programming information for ease of use. Unlike the CD-ROM, the videodisc is an analog format. The recording is simply a different form of the video signals. As a result, picture resolution is limited. However, stills, print, film and music can all be used in one disc.The material is programmed for indexing by computer and through questions, menus, etc. any image or page can be located almost immediately with scanning techniques .

Interactive videodisc technology (IVT) exists on different levels of sophistication from very basic to advanced interfacing with computers. It is currently in use as a learning system in schools, hospitals and businesses. For example, several training manuals can be incorporated into one disc and programmed for self-paced instruction. The Library of Congress was to institute an interactive patron training disc which would "free reference librarians from repetitive tasks of beginner training." (Nugent and Harding) The L.C.'s "Optical Disc Pilot Program" demonstrates many of the most useful potentials of IVT for libraries. Eight disks

were created, six of them laser video discs and two digital audio disks. One of the primary purposes was for preservation of materials. Certain rare and delicate materials, such as early motion picture film, were taped and indexed for disc thus preventing handling and further degradation of the film itself. Film can be studied using special effects techniques such as slow motion and freeze frame that would not be available with a projector. Researchers can browse through photographs and prints without having to handle them, though serious study might still require something closer to the original material due to the current resolution limitations of video. Museums have already produced discs which give the viewers a guided tour through the museum's collections, and schools already have some educational IVT programs available to them. The medium is clearly well enough established to allow standard playback and microcomputer interfaces to become widely available in the near future. The actual production of the initial master disc is still quite costly, but printing of the discs has dropped to very reasonable levels.

CD ROM

CD ROM is an entirely digital version of the optical disk. Used for text, one disk has a capacity of nearly a quarter

of a million pages of a book. As players for these read only disks are appearing (again for interfacing with computers) production of various databases on disc are also underway. Grollier's Academic American Encyclopedia, a twenty-one volume set, will soon be available for around $200.00. The storage capacity of one CD ROM is so great, that this set and a complete keyword indexing (which uses more memory than the encyclopedia itself) is contained on one disk with plenty of memory left. A bibliography of millions of L.C. holdings are available on disk through the Library Corporation of Washington D.C.. Write once, read many times (WORM) disks are very new and making a tremendous impact, as the only drawback of CD ROM's had been that they were not updatable as databases. Widespread recordable disk technology is not far off, however. When libraries can produce their own disks inexpensively, they may replace magnetic formats altogether. Optical scanning equipment and the technology of OCR (Optical Character Recognition) will allow conversion of various materials in print to machine-readable formats which would permit tremendous holdings to be stored and accessed on a few optical disks.

Audio-visual departments and music libraries contain a tremendous amount of materials on tape (cassette and open reel) and phonodiscs. Tape recorders and turntables will remain an integral part of these areas. But music libraries

also are beginning to take advantage of this recently introduced compact disc format. This is another kind of CD-ROM, one for digitally encoded music. One disc can contain over an hour of music, with indexing instructions programmed into it for rapid access to any "band" or selection. Besides advantages already discussed concerning [illegible] CD's offer excellent fidelity and an absence of tape hiss and the surface noises which plague phonodiscs. Their "sonic realism" is due to the digital recording medium. If the music is recorded live digitally, then successive generations required for production of a master disc have no signal losses (as with analog recording). The final product is limited only by the initial recording techniques e.g. microphone choice and placement, and the quality control in the mass production of the discs themselves. Certainly the good quality enhances the listening and studying of music, but there is still another advantage. A student or researcher can program the player to repeat a specific phrase of music endlessly for analysis or transcription. This factor alone is a boon to music studies. Music libraries will be incorporating players into their listening systems, and purchasing fewer and fewer phonodiscs in favor of compact discs.

TELETEXT/VIDEOTEX

In the realm of electronic communications, teletext and videotex are general terms for two kinds of information transfer over airwaves or telephone lines. Teletext is basically a one-way system of broadcasting data - usually news - that is constantly changing. As a public service, it might have a place in the reading room of a public library, a special terminal with a decoder would receive current stock prices, for example, for patrons wanting more current information than was available in the newspapers. Videotex is a type of on-line database. It is a two-way, interactive system using telephone lines or cable transmission. Terminals can be dedicated or additional hardware for interfacing with microcomputers would allow users to "call up" text and graphics available through a subscription to a particular service. This is very similar to current database and electronic mail systems.

MICROFORMS

Change in the area of micromaterials could not be as rapid as in those discussed above. Their present advantage over other forms of information storage are that they are easily and cheaply produced, and that the quality of reproduction for demanding materials such as maps, drawings and art reproductions is excellent for study. Microfiche and film

printers are improving and will probably drop in cost. However, slow and laborious handling remains a drawback, as does their eventual degradation through use. Though there is bulky and expensive equipment for storing and accessing microfilm in a somewhat faster and more efficient manner, this medium will probably maintain a low profile in libraries of the future. Other formats for information storage will grow and change faster, with tremendous amounts of material becoming "digitized", leaving microforms for more special purposes which demand their photographic accuracy or low cost production.

## Conclusion

The primary concern before purchasing new systems must be regarding compatibility and expandability of the equipment. Libraries will be attracted to many new on line and self-contained systems whose terminals or work stations are dedicated to one kind of use only. This will generate tremendous waste in the long run as future technologies will require many similar pieces of hardware. This is currently the case in the computer industry, where compatibility is now becoming essential for ease of communication between computers. Manufacturers will need to create standardization in areas such as disk types, sizes and drives, interfaces, and other types of hardware to prevent quick obsolescence in this ever changing information industry. Audio technology seems unable to go much farther than the digitization of audio and the compact disc - true high fidelity. Graphics and video technology have room to improve, at least in the area of video picture resolution. This will change research in the visual arts and sciences when integrated with laser technology. It seems clear that library administrations and staff will have to remain informed and even more future oriented in their purchasing decisions than ever before, if this kind of waste is to be avoided. This will be a

great challenge, but the prospects certainly are exciting for the next generation of libraries.

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# TELECOMMUNICATIONS AND NETWORKING

"The basis of today's telecommunications revolution was the marriage of communications technologies and data-processing technologies."[1]

## INTRODUCTION

The supporting technologies on which present and telecommunications systems in the foreseeable future are structured include: solid state engineering, microelectronics and the development of today's sophisticated computers; wire- and space-based transmission media including, coaxial cable, optical fiber, microwave and satellite dishes, photonics and fiber optics. Satellite communication systems which use all these technologies are converting the Earth into a "world village" tied together by dependable telecommunications, television, teletext and computer links.

## SUPPORTING TECHNOLOGIES

### Microelectronics [2]

Possibly the most important supporting technology has been the development of solid state microelectronics and software.

Microelectronics emphasizes the miniaturization of both individual electronic components and complete electronic circuits. The integrated circuit, an electronic circuit in a semiconductor "chip", is a major achievement of microelectronics, making possible the development of smaller (mini, micro and lap computers) and more efficient computers. The individual components of an integrated circuit can be packed closer together (hundreds of thousands per chip) and produced much less expensively than the circuitry it replaced.

The microprocessor contains the arithmetic, logical and control circuitry necessary to perform the functions of a digital computer's central processing unit can be compressed

1 Schroeder 97

2 A readable history of microelectronics and computers is T.R. Reid's The Chip.



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onto minute silicon chips less than 0.2" square. Sophistication has advanced such that the computer of the 1960s, able to multiply 2 ten-digit numbers in 1/100,000th of a second, has been replaced by smaller, more efficient computers that today perform the same operation in billionths of a second (nanoseconds).

Solid state engineering ushered in computers that were faster, smaller, more durable and reliable, less expensive and had computing capabilities far beyond the earlier vacuum tube based computers. The virtual storage capacity of today's computer enables users to work efficiently with millions of characters of information, seemingly non-stop.

Developments in programming (i.e., software, or instructions to the computer) continue , although not at the same dramatic rate as developments in hardware. However, specialized programs for problem areas--list processing, data base management, information retrieval, simulation of operations, automatic print composition, remote-access, time-shared conversational interaction between humans and computers, continue to increase the utility of computers.

Software for specific business and personal applications, the miniaturization of the microcomputer to a desktop size with large computing and storage capacities, and decreases in the price of computer hardware, have put computers within the reach of most businesses. The desktop computer is also as an essential adjunct for many self-employed entrepreneurs, researchers, and as an adult "toy" for personal, leisure pursuits.

Digital transmission

**Analog transmission** systems, such as that used for the telephone, convert sound into electrical signals that are replicas or "analogs" of the sound itself. These electrical signals are converted back into sound at the receiving end. The "bandwidth" or carrying capacity , for analog is 3-4 000 cycles per second. In **digital transmission**, sound is converted into "pulses" which are measured (i.e., sampled) at frequent intervals and the measurement is transmitted; the sound is reconstructed by computers at the receiving end. The bandwidth for digital must be much wider than for analog. It takes 64,000 "pulses" per second for the transmission of the human voice, for example.

The advantage of digital over analog transmission is that the digital pulses are regenerated when they are weakened or distorted by transmission. A pulse generator sends out a new stream of pulses that corresponds to the received pattern. In this way, much of the distortion introduced by the line is eliminated; there is a "fresh start" each time

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such that messages are received without significant loss or distortion.

## TRANSMISSION MEDIUM

Coaxial cable, microwave relay stations, satellite dishes and fiber-optics are ways of transmitting the larger bandwidth necessary to transmit digital impulses. These various kinds of telecommunications media often interconnect and mix in a single system or in overlapping systems.

### Coaxial cable

Coaxial cable provides a path for transmitting electrical energy through a cable with a tubular outer conductor that encircles a concentric inner conductor; the 2 conductors are separated by insulation. This construction makes it suitable for transmission of high carrier frequencies. In the U.S., coaxial cables are bundled together in 1 protective covering that surrounds as many as 20 coaxial cables. These coaxial cables are used in pairs, one cable in a pair for messages in one direction and the other for messages in the other direction. With the appropriate carrier systems, such cables provide as many as 3600 voice channels per pair. A line containing 20 coaxial cables provides 32,400 voice channels (9x3600) with 1 pair as a spare.

### Microwave relay stations

Microwaves consist of high frequency electromagnetic radiation. In telecommunications microwaves are used to carry information for telephone and television systems. Microwaves can carry more information than radiowaves because information capacity is proportionate to frequency and microwaves have a higher frequency than radiowaves. Microwaves pass directly through the upper atmosphere without being reflected back to the earth, so a signal from a transmitter cannot normally be picked up by a receiver beyond the horizon. Transmission of microwaves beyond line-of-sight distances requires construction of a network of microwave relay stations placed at 40km (25 miles) apart or on top of tall towers situated on hilltops, or the use of communication satellites as relay stations to give an unobstructed path between stations. Because of their high frequency, microwaves can be accurately directed in a narrow beam from 1 transmitting antenna to the receiving antenna of the next relay station.



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Fiber optics

Photonics, the transmission of sound or other information by light wave, is based on fiber optic technology which converts voice, tv or data signals into brief pulses of light that are sent throught strands of ultra-pure glass or other optically transparent materials. **Lasers** (**L**ight **A**mplification by **S**timulated **E**mission of **R**adiation) are devices that generate "well-organized" light. Lasers generate pulses at 45 million per second--just the frequency needed to transmit color tv signals. With fiber optics, light pulses remain within optical fiber, no matter how twisted or bent the fiber becomes; the pulses can travel long distances without reinforcement. Fiber optics has a number of other advances versus other transmission systems including its size: 72 pairs of fibers equals a cable no thicker than a finger but which can handle 300,000 2-way phone calls; it makes dependable, noise free phone circuits; is corrosion proof; and highly resistant to electronic eavesdropping.3 The expense of replacing coaxial cable or twisted-pair wire (traditionally used in telephone systems) with optical fiber, the systems of repeaters needed for optimum optical transmission and the cadre of specially skilled personnel needed to install and maintain the system, have been constraints of its use. However, AT&T has begun to lay optical fiber cables in several sites across the country, including the University of Pittsburgh where optical fiber will constitute the backbone of their transmission system.4 UC Berkeley's new communication network will use fiber optic cables.5

Satellite communications

Satellites act as "very high microwave towers", receiving signals from a ground station and retransmitting them over a very broad area.6

A satellite communications system comprises the satellite itself with the necessary control and tracking facilities and the associated earth stations. Satellites in a geosynchronous orbit (i.e., an orbit which approximates the earth's of about 24 hours) will seem to have a fixed position in the sky and a fixed altitude, thus making it possible to cover approximately one third of the earth with one satellite, and approximately 90% of the earth's surface with three equidistant satellites.7 Thus, with a few

3 Schroeder, 101-102
4 "Campus lays networks for the future", 11
5 DeRieux, 1
6 Schroeder, 102
7 "A guide to satellite communication", 9

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satellites the continuous, uninterrupted communications between points on earth is possible. Signals are transmitted via satellite between earth stations connected to the existing terrestrial telecommunications systems. Broadcast satellites receive television programs from an earth station. These programs are broadcast from the satellite for reception by individual home receivers or are received and redistributed via cable over a limited area; by network tv stations to their viewers, or are received by individuals with their own satellite dish.8

One of the advantages to satellite communications is its flexibility: through satellite communication facilities it is possible to serve multiple routes through a single facility and to reallocate channel capacity among these routes. So in addition to point-to-point communication between pairs of earth stations, it is possible to provide point-to multiple point transmission from one earth station to a number of earth stations which can be activiated and deactivated at will without affecting the overall system. Thus the ability of cable television to offer satellite broadcast programs to selected viewers who are willing to pay an additional fee to see a special event, such as a boxing match or a live concert.

Capacity is another advantage: Satellite systems not only provide capacity for the simultaneous use of many channels for traditional services--telephones, telegraph, etc., they can also furnish new broadband services. Communication satellites are used for digital transmission of voice, data and imaging. Satellite based telecommunication systems have the capacity to be used for teleconferencing, television, document delivery and data communications.

Satellite systems provide interconnections over very long distances. They can also be used for limited areas with the use of highly directive antennas. Although the initial outlay is quite expensive, the cost of a link between two earth stations via satellite is largely independent of the distance separating them, versus the cost of some terrestrial systems which increases with the distance between points.9

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8 "A guide to satellite communication", 10-11
9 "A guide to satellite communication," 12

## THE UCSB TELECOMMUNICATIONS SYSTEM 10

### Elements of the present system

The UCSB campus telecommunications network and its links with the UC telecommunications system typifies problems, solutions and goals of campus telecommunications network systems in a distributed computing environment.

The UCSB telecommunications system features

--a UCSB-owned private branch exchange (PBX), the GTE 4600E Electronic Telephone System, which utilizes a digital telephone switch;
--a broadband communications network using twisted-pair and coaxial cable wiring;
--a microwave relay station located on top of the second story UCSB Library building;
--satellite dish which is used for video reception only.

An important step in establishing UCSB's emerging integrated local area telecommunications network was the installation of the GTE 4600E Electronic Telephone System in 1985. The campus-owned PBX allows UCSB to route all calls from any on-campus location to another on-campus location directly through the PBX system. Off-campus calls are routed to the GTE-owned switch at Ellwood Beach. Since approximately 90% of the calls made at UCSB are on-campus, by routing the calls through the campus switch UCSB has been able to decrease the unnecessarily large amount of twisted-pair telephone wiring maintained between the campus and the GTE central office. Now, instead of the 3200 pairs of twisted-pair wire previously used for all UCSB telephones, about 320 twisted-pair wires are needed between the campus and the GTE central office to support those telephones which are making off-campus telephone calls. In addition, almost all of the GTE-owned rotary phones were replaced with campus-owned touchtone telephones. Owning our own PBX system avoids upkeep and replacement cost of the wiring as well as avoids the impact of (further) rate increases from GTE. A savings

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10 Information used in this section has been compiled from conversations and correspondence with Clifford A. Lynch, Manager, Computing Resources, University of California Division of Library Automation; Charles R. Loepker, Director, UCSB Information Systems and Computing; Clifford A. Lynch, ; Vince Sefcik, Director, Communications Services, UCSB, and member Systemwide Communications Planning Group, and from memorandum from the UCSB Information Systems & Computing Office and from the Office of the Vice-Chancellor, Adminstrative Services, UCSB.



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of $5.3 million is projected over the (amortized) life of the telephone system.

Because digital transmission is much faster than analog, the basic functions of the telephone switch--connecting a caller and the called party for a local call; or caller and central office for an external call--are performed much more rapidly. The switch itself is digitally controlled and operated, i.e., controlled by computer programs. Thus, with the use of the touchtone telephones, it provides various customized services (call forwarding, speed dialing, conference calling, etc.) to the campus by simply changing the data used by these programs.

Currently the function of the PBX for data communications is to connect the broadband network with off-campus users who can attach a modem (a device which changes digitally coded output to analog, for transmission over telephones lines) to their computer and reach the network via telephone. The UCSB telephone system, utilizing the existing twisted-pair wiring as the transmission medium, can support only low-speed data communications. A broadband communications network was implemented in 1984 which can handle high speed communications. The capacity of the switch to support both voice and data communications, and to interconnect compatible terminals and computers, will contribute to the interconnection of the voice and data networks among the UC campuses.

The UCSB broadband network

The computing environment at UCSB has changed from a centralized structure where the Computer Center provided computing services to all campus users based upon the use of a large ("mainframe") computer with massive computing and storage capacities, to a decentralized environment where departments own and operate a wide variety of mini- and microcomputers to support their own administrative, academic and research computing needs. A broadband communications network utilizing coaxial cable as the transmission medium was chosen as the solution to problems connected with this distributed computing environment.

The UCSB broadband network is a product of Ungermann-Bass Inc. The term "**broadband**" defines the physical transmission medium, in this case, coaxial cable, which carries the electronic data messages.

Twisted pair wiring is used to connect telephones back to the telephone switch and microcomputers to a central point, a wiring center in a building. Coaxial cable is used to interconnect the wiring centers. With simple wiring, microcomputers in buildings with broadband can send information to other buildings. Using twisted pair wiring



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for intra-building communications is reasonable since it has been found that most data travels no more than 350 feet; therefore, long distance communication systems for most users is unneccessary.

Although twisted pair wire is readily available as it can be found wherever there are telephones, high-speed data transmission is accompanied by much noise on the line. Noise can be tolerated for voice communications, but is detrimental for data communications. Twisted-pair wire also tends to be packed closely together, causing a phenomena called "crosstalk". Because of these problems, the signal must be amplified frequently to strenghten it and filter out the noise. Crosstalk is not a problem with coaxial cable because it is very well insulated. Coaxial cable also requires fewer amplifiers than twisted-pair wire, is less expensive than optical fiber, yet has a much high carrier capability and can be used for wide bandwidths.

**Bandwidth** is the range of frequencies (cycles per second) that can be carried by a transmission medium without undue distortion. This is crucial because both the quantity of data and the rate of speed of data transmission (measured in bits per second (bps) are proportional to bandwidth.

Wider bandwidths are important because they can be divided up into multiple channels (i.e., transmission paths). This way, the transmission medium can be used for transmitting more than one signal at a time, with each signal operating at a different absolute frequency so that the signals do not mix. Additionally, on a broadband network, each channel may be used for a different communication system, each of which can be a separate network.

The UCSB broadband network coaxial cable has 17 channels at 5 million bps (bits per second) per channel its carrying capacity is substantially higher than twisted-pair wire which has only one channel and therefore has a maximum carrying capacity of 9600 bps.

Broadband as a local area network (LAN)

One concept which has shaped the development of UCSB's telecommunications system is the model of the local area network. In terms of data communications, a **local area network (LAN)** is a communications network which interconnects computers, workstations, and terminals within a limited geographic area thereby providing for the sharing and exchanging of data. The UCSB broadband network performs this function.

The benefit of networking for data communications is the ability to share information and use the resources of physically separate computer devices such as a terminal



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(with or without a video screen), a printer, a mainframe, a minicomputer, or a microcomputer.

The **topology**, the physical configuration of the UCSB broadband network, is an inverted tree. A device is readily connected to the network by simply tapping on to the trunk. In tree topology, no one node is responsible for the processing and routing of all messages, which allows for higher reliability.

A number of communication tasks must be performed before any devices are considered "connected". "**Protocols**" are the set of control procedures which govern the format and timing of any information exchange, thus making the devices compatible and therefore capable of being connected. To provide connection services for otherwise incompatible vendor products, the UCSB broadband network supports a number of different protocols, so incompatibility between vendor products is no longer such a problem. Although almost any product can connect to the network, the connection does not, however, guarantee a complete translation of messages from one device to another. Some computers do have computer programs to do certain translations between vendor products. However, it is up to the user to determine this, to take appropriate action when this is not the case, and to coordinate or synchronize any two devices which will be passing data between them, ensuring that the receiving device is prepared to accept the message in the format intended by the sender. Thus, for example, the library would need to arrange to have its hardware configured or buy the necessary translation programs to support one type of hardware working with another either between equipment in the Library or elsewhere on campus.

Bridges and gateways allow for the connection between separate LANs, both local and remote, through message passing, congestion and flow control, and protocol translations where necessary. A **local bridge** allows the integration of various technologies on one network, such as when a device attached to the broadband network wants to connect to another device on a baseband network. A **remote bridge** allows interconnection to a geographically removed network of the same technology. A **gateway** provides access to a separate, technologically distinct network such as the national networks (e.g., Telenet, Tymnet, Arpanet) supported by the UCSB broadband network.

The broadband network benefits UCSB's computing and communications needs in many ways. The network supports the connection of otherwise incompatible devices; has the capacity to support an increasing number of devices; allows the gradual replacement of deteriorating wiring with coaxial cable; has the capability of supporting other communication



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systems which had been independently installed and maintained; and carries out high speed data processing communications with minimal noise on the line.

In summary, major goals originally identified for a UCSB network were to replace the existing network facility, characterized by deteriorating cable, capacity constraints, and other limitations, and to provide service for the fire alarm system, educational tv, Cox cable tv, energy management, and possibly telephone communications, each of which had its own separately maintained cable system. In addition to meeting these requirements, the network provides numerous other functions and features including, but not limited to:

--support of 24,000 devices using less than 25% of the available bandwidth;

--improvement of data integrity through the use of coaxial cable and redundant cabling, thereby providing both immunity to outside interference, and backup capabilities should there be a failure in one cable;

--increase in the speed of data transmission; 9600bps for terminal service and up to 5 million bps for transferring files between hosts;

--network may be programmed to handle unique protocols as well as the many standard ones it supports now which allows for connection of most vendor equipment;

--high speed file-to-file transfers using the network's file transfer facility eliminates the time consuming and costly task of first dumping a data file onto a tape, physically transporting it to a new machine, and then reloading it;

--significant expansion capabilities, including the capability of the network to support sharing of databases, video data, and voice communications among the various UC campuses.

Future enhancements to the UCSB telecommunications network

Two additional satellite dishes, to be used to receive video broadcasts and distribute them via the broadband network will be installed during April 1986.

With simple wiring, microcomputers in buildings with broadband can already send information to other buildings by April 1, 1986, campus microcomputers wired to the broadband network will be able to send information to UCSD.



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Present and future communications links to other campuses

Currently, UCSB is linked to University Hall and UC Berkeley through the microwave dish which is used for medium speed (50,000 bps) data transmissions, and to other campuses through telephone circuits. The dish has 2 channels: one channel connects the UCSB Computer Center's mainframe computer to the Office of the President in Berkeley. This channel is used for transmitting payroll, retirement, and other accounting and administrative information. The second channel is used by the Division of Library Automation (DLA) for MELVYL transactions.

The use of the microwave dish is being phased out. A T-1 trunk, which is less expensive than the microwave dish (due to the charges from the off-campus vendor providing the facilities), is projected to be in place by this summer. The trunk will tie UCSB to UCLA and UCLA to UCSD and UCSB.

The **T-1 span** is a communications trunk which uses twisted pair wiring, specially shielded to insulate the wiring from noise distortion. This trunk is divided into 24 channels at 64,000 bps per channel so that its carrying capacity is 1.5 million bps. Each channel can carry voice, data or video and each channel can be used for a different type of communication between any two interconnected nodes. For example, one channel of the T-1 trunk can carry voice from UCSB to UCLA; UCLA may then use the same channel to send a different message, perhaps a data communication, to UCSD which in turn may utilize the same channel to send UCSB a message via video. The benefits of integrating multiple communication systems on one wide area network is the connection of different communications devices (on separate communication systems) in a common cabling system. This eliminates the separate cabling required by each system and therefore lowers costs. The use of the T-1 trunk in this manner represents the multifaceted capabilities of an integrated LAN which supports voice communications, video conferencing, video broadcasting, and other electronic communication systems.

On a Universitywide basis, UC had planned to build an intercampus telecommunications network which would accommodate voice, data and limited video traffic utilizing digital microwave, satellite and/or other broadband technologies. In 1983 requests for proposals (RFPs) for such an intercampus network were sent out to 110 vendors; 3 submitted proposals. None of the three could comply with the terms of the contract. So, a revised plan was



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formulated to support an intercampus network utilizing a variety of telecommunications media: leased lines from AT&T, private and state microwave, satellite links, and phone lines obtained from common carriers.

At the initiative of UCSB, high speed communication links, T-1 trunks are to be installed to serve some of the southern campuses. T-1 trunks between all UC campuses are presently being evaluated. Such links may prove to be the method by which the intercampus network is established.

UC prototype packet radio network

Packet radio is being investigated as a communications system to meet the growing needs of the University of California for the greater bandwidth necessary for data communications and as a means of decreasing the maintenance and expense associated with wiring and cabling of campus buildings or entire campuses for computer installations, expenses which in some cases may cost as much or more than the terminals themselves.11

The University of California Division of Library Automation's prototype wide-area packet radio network in Northern California is scheduled for initial testing this summer (1986). The prototype will be installed at six locations from Berkeley to Sacramento.

The packet radio network combines two technologies, radio and packet switching. Except for a connection to an electrical outlet, data communications via radio does not require an extra cable or wire for the terminal. The minimal wiring increases the portability of the terminals and their quick installation in libraries and other buildings on campuses. Data will be carried by radiowaves via a system of transmitters, receivers, and antennae between each campus and the Division of Library Automation (DLA) for MELVYL (TM) transactions. A microprocessor at each library will be responsible for "packet-switching" and message sorting. In packet-switching, data being transmitted is broken into small digital packets which have a home and destination address. The microprocessor forwards the packets to the correct destination, in this case to DLA's computer, for processing and returns it to the correct destination, i.e., the originating terminal or computer at the local campus.

Present funding for the project is through the Federal Library Services & Construction Act administered through the California State Librarian's Office. DLA has applied for supplementary funds for fiscal year 1987 to expand the

11 Brownrigg, Lynch, and Pepper, 229

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prototype network and to begin to make the necessary improvements for its eventual use throughout the system.12

## RECOMMENDATIONS

1. The establishment of a Library Technology Office, adequately equipped and staffed. This office would, among other functions:

--address telecommunications issues which affect or may affect the Library;

--maintain informed technical staff who would keep abreast of campus and Universitywide telecommunications issues, and be able to advocate for planning, equipment, changes, etc., which would be in keeping with overall Library goals and objectives;

--educate Library personnel on telecommunications issues;

--investigate new telecommunications technologies for use by the Library. For example, FM wideband transmissions currently bring microcomputer subscribers who have specially designed radio receivers in their computers up-to-the-minute stock trading information. Paging, electronic mail, and local information exchanges are other possible uses. Will the Library be able to use FM sideband or vertical blinking interval (VBI), primarily used now for transmitting closed caption text for the hearing impaired, for new Library functions such as transmitting new book or in-process information, schedules of patron education activities or other Library announcements to the dormitories or other campus or off-campus locations? Will we use telephonic voice synthesis systems to give automatic answers electronically to routine questions typed in on a touchtone telephone about library hours, circulation information, etc?13

2. The issue of the Library's (future) relationship with the UCSB office of Information Systems and Computing be explored by the Library. At UCSB the role of the library as the campus information center is being seen as changing as ..."trends in information storage make it inevitable that the computer center will become the principal information storehouse. The library, in turn, will become an academic information service organization..."14, i.e., performing a document delivery service and serving as a study hall for undergraduates.

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12 Lynch and Brownrigg, 7
13 Yatagai, 56h
14 DeRieux, 1



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NETWORKS

## National library networks

Library networks are "...both the organizations and systems that link libraries together, and increasingly that will link libraries to other information sources and services, via telecommunications systems".15 The key element in the network is a file of records, i.e., a database, which represents the sum of both MARC records and members contributed copy. Member libraries gain remote access through terminals or teleprinters at the local library which are connected to the central computer through telephone lines. Members most often copy, modify or add records in the database. In turn, the utility supplies to the local library a magnetic tape copy of its contributed cataloging. These tapes can be used to generate in-house files: cataloging, circulation, serials control, acquisitions, reference, etc. Communications between the central computer and the member "nodes" (libraries) is supported by telephone lines from the central computers to several terminals which share the cost of the leased line. This type of organization describes centralized computer-based library network systems such as the Online Computer Library Center (OCLC), Research Libraries Information Network (RLIN), and the University of Toronto Library Automated Systems (UTLAS).

Organizations which support a wide variety of resource sharing functions, through the provision of training, consulting, planning and funding, are regional and state cooperative networks such as CLASS (California Library Authority for Services and Systems). State, regional or local networks may provide special reference services (e.g. SCAN, the Southern Calif... ...ng Network). Special interest networks such as the Water Resources Scientific Information Center provide services and information for specific user groups.

## Library networking concepts

The concept of library networking grew out of a theoretical framework already at work in the U.S. library community: the recognition that no library can be totally self-sufficient in terms of its collection; cooperation and sharing of resources among institutions; and, beginning in the 1930s and '40s, the advocacy and use of data processing to handle some library routines.16

15 Markuson, 4-5
16 Reynolds, 9-40



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It was not, however, until 1968, with the beginning of the MARC Pilot Project and the distribution of MARC records (MAchine Readable Cataloging, the format for the transmission of machine-readable cataloging data developed by the Library of Congress) "with almost no direction as to how they [MARC records] might best be used"17 that the impetus and the technology needed to begin library networking emerged. Six New England land-grant university libraries formed NELINET (New England Library Information Network) and the academic libraries in Ohio formed the Ohio College Library Center (OCLC) in 1971. OCLC began to provide on-line service to a single library with one terminal linked to OCLC's sole computer. Today, OCLC serves nearly 3000 terminals in nearly 2000 libraries; its network system requires a complex of some 30 mainframe and minicomputers.18

Library networks have shared the following characteristics:

1. They are based on a concept of shared resources;

2. The development and cooperative use of a large scale bibliographic database in machine readable form;

3. The centralized nature of network technology, administration and focus;

4. Initially, the use of batch mode automated systems, and later on, of interactive automated systems;

5. The reliance on commercial telecommmunications systems to link libraries to one another and to the centralized facilities designed to serve a group of libraries;

6. To some degree, the loss of autonomy for the local libraries;

7. The centralization of network services;

8. Increased productivity and decrease in the rise of per unit costs for the local libraries.

A further concept that was shared was the belief that all library services could (eventually) be automated at the network level.

The nature of library involvement in networks, however, is changing, in large part due to the availability of new technology which allows libraries to build local on-line technical processing systems.

17 Markuson, 35
18 Markuson, 6



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"The cost of the long-distance phone lines that tied RLIN terminals to the central computer at Stanford was rising sharply. With a growing number of users of the multimillion-record database, continued growth was a challenge. And, most significantly, the cost of computing hardware was falling as dramatically as its capabilities were growing. The result was that a member library could now consider the possibility of doing much of its processing work on a local system geared to its individual needs, and in many cases tied into a local area network (LAN) being installed to serve its campus." 19

The response of the Research Libraries Group (RLG) to the changing needs and technology of its clientele typifies the response of the major utilities. To bring its centralized system into configuration with the new and future needs of its users, RLG began in 1979, to plan a "second generation" architecture, a distributed network of heterogeneous local systems or "local nodes", with the RLIN system serving as a data resource node. "Network (database) servers" are microcomputers that interconnect the local nodes with the RLIN database, "thus allow[ing] members to take on technical processing functions--providing on-line catalogs of their own collections, circulation control, serials control, acquisitions, and possibly cataloging with the database server at RLG providing a union database for the continued support of RLG's cooperative programs in resource sharing, collection development, preservation, and bibliographic control". 20

According to David Richards, RLG's Director of Research and Development:

"You can install a local system now and use it for functions such as on-line cataloging, but without linkage, the local system would not have access to the union database, which is essential to the support of scholarship....The LSP protocols set down the rules used to communicate, and the network server is the mechanism that will allow the communication to take place". 21

The Linked Systems Project (LSP), now in its final testing phase of a 5-year project, is developing a set of protocols (communication procedures), which will enable the various library networks and eventually, local library systems, to "talk" to one another coherently, and therefore be able to share information with each other. LSP involves RLG, LC,

19 "RLG evolves to meet new challenges...", 3
20 "RLG evolves to meet new challenges...", 3
21 "RLG evolves to meet new challenges...", 3



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WLN and OCLC in the first major technical project all four have undertaken together. 22

The ideal of the single, national database has given way to the realities of modern library organization: "It became clear in the late 1970s that, desirable as it might be, we were not going to see a single, national database in this country. So the way to capitalize on the modest, but growing, number of bibliographic databases was to create the protocols that would allow communication between them." 23

Distributed networking potentially threatens the integrity of the union database as well as the networks' financial structures by making it cost effective to do many technical processing functions at the local level. In a centralized network, contributions of data to the shared database are byproducts of processing, as is revenue for the network since revenue is based on charges for transactions on the database. However, in a distributed network, as activities are carried out on the local level, members must make a conscious decision to add their locally processed data to the database. And, since those technical processing activities once done through the network may no longer be processed on the network, but in the local system, members must decide what information is essential to maintain the network database, and what kind of financing system is justified.

Value added networks (VANS)

**Value added networks** (VANS) are communication networks provided by a commerical vendor, like TYMNET OR TELINET, who lease large numbers of telephone lines, provide packet switching (i.e, high speed data transmission) and communications equipment capable of serving thousands of simultaneous calls from terminals and forwarding and receiving messages. Online bibliographic search service vendors pay to connect to the VAN's network of telephone lines. A library or individual subscriber places a call through TYMNET to reach DIALOG (one of the search services), for example. TYMNET's packet-switching equipment will forward the user's requests to the search service's computer for processing and return the response to the proper user. Users pay fees for the telecommunications connection: time on the databases searched, royalty fees, the characters transmitted and citations retrieved.24

22 "The Linked Systems Project...", 11
23 RLG
24 Epstein, 124

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Future trends--toll-free access

Recently TYMNET and a local telephone company, Southern New England Telephone Company (SNET), agreed to offer toll free services to the more than 1400 information and computer services available through TYMNET to TYMNET users in Connecticut. This agreement marks the first time an international value added network and a local phone company have participated in this kind of statewide interconnection. At least two other similar joint undertakings are being planned. 25

FUTURE CAPABILITIES--TYING IT ALL TOGETHER WITH SCHOLARS' WORKSTATIONS

Both RLG & OCLC are looking even farther ahead to the time when the union database residing on the utility's mainframe is accessible from **scholars' workstations** (microcomputers with enough computing power and with the appropriate telecomunication links to access remote databases free from long distance communication charges). As a step in that direction OCLC has developed the M300 workstation and RLG, the PC version of an RLIN terminal. Scholars' workstations will be used in all areas of library work (technical services, public services, administration) and by the individual user to:

--perform tasks at the appropriate levels, whether they be local, regional, national or international;

--load records into optical disks or other high-density memories as they become available;

--deliver electronically the contents of books and other library materials;

--operate 24-hours, seven-days a week;

--transmit textual, numeric, and graphic information as well as bibliographic data;

25 "TYMNET and Souther New England Telephone link up for first-of-its-kind service...", 11



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--access OCLC, RLIN and other utilities' databases, online bibliographic databases, other academic online catalogs, and other remote and/or local databases;

-- develop reference services that could employ both online and optical disk technologies;

--transmit facsimile copies of documents;

-- publish electronic journals and other documents;

--electronically browse monographs and other works;

--integrate bibliographic control information with other forms, such as abstracting and indexing information, making customized retrievals possible.26

## RECOMMENDATIONS

1. The Library should connect all computers to the broadband network, which will ensure library personnel and patrons access to Computer Center and other campus resources as well as access to the information services which are available through TYMNET and TELENET, both of which are accessible through the broadband network, and other remote services.

2. The Library should replace all terminals with microcomputers, so that library personnel and patrons can take advantage of the downloading, data manipulation, and accessing capabilities of the computer.

3a. Microcomputers should be outfitted with modems, telecommunications and gateway software which are used for automatic dialing and log-on. Gateway software provides search assistance for accessing multiple databases.
3b. Microcomputers should be equipped with electronic scheduling and electronic mail service systems.

4. Direct access to MELVYL (TM) (via the assignment of Computer Center ports) should be made within the year.

5a. The Library should establish regular faculty/librarian interface around automation/technological issues:

--computer aided instruction
--integration of courses and search systems in the Library
--demonstration of discipline specific research techniques using computers, etc.
--provision of free database searching for specific classes (with support from Instructional Development).

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26 "A special report...", 1;"Preparing for the "Third generation", 9



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5b. There are varying levels of knowledge of available computer systems (DIALOG, ORION, etc) among public service personnel. A base level of knowledge is needed by all public service librarians, for example. With the proliferation of materials and services accessible online, the public service librarians can no longer remain untrained in these areas and provide good public service. Therefore the Library should:

--set minimum levels of knowledge of systems and train all public service personnel in them. (e.g., a minimum standard might be that all reference personnel have a working knowledge of the protocols of BRS and DIALOG; as well as RLIN & ORION);
--set minimum levels of knowledge of systems and train all public service student assistants in appropriate systems, e.g., basic MELVYL techniques to find author and title information. Students serve at many points as the sole backup of library assistants and/or librarians. When professional assistance is unavailable they often provide "reference assistance" which they give as best as they are able. Unless appropriate professional assistance is available at all service points at all times, these students must be trained.

5c. Public service personnel should be trained to use and manipulate databases and computer software and components that will be most used by researchers. These would include word processing packages designed for bibliography, footnoting, indexing, outlining and other document and dissertation preparation procedures; in addition to the commercial bibliographic databases, special databases such as RLIN's Eighteenth Century Short Title Catalog (ESTC) accessing records cataloged under the revised MARC formats for Archival and Manuscript Control; statistical packages; modeling and simulation packages.27

INTERCONNECTIVITY

The issue of interconnecting the many components necessary to make the envisioned scholar's workstation and information network--where a user could have "transparent" (i.e., easy and unobtrusive) online access from her/his computer to the local and systemwide catalogs, to other university catalogs, to a wide variety of library, national and international information networks of data, visual and graphical information--have not yet been resolved. The components of such a network exist and, in fact, a national and international network is taking shape.27 However, a number of technical problems, all theoretically resolvable, need to be worked out. For example, protocol software must be

27 Lynch, 5-7

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compatible not only with software on other computers but also with gateway software and hardware which connects this network to another; troubleshooting; locating users or resources; accounting and security procedures have not yet been worked out.28 Problems with networking electronic mail systems pose particular problems: "There are a variety of protocols and standards for interconnecting electronic mail systems, and such interconnection is quite complex. These protocols presuppose the existence of network links of some kind between the computers hosting the mail systems, but there are many other problems to be addressed, including how to route mail, how to figure out where someone's mailbox is (i.e., on which computer), what to do with undeliverable mail, etc."29 Technically these problems are resolvable, when, however, remains to be seen.

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28 Lynch, 7-11
29 Correspondence with Clifford A. Lynch

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## TECHNOLOGY TASK FORCE RECOMMENDATIONS

The following overall recommendations are designed to bring the UCSB library to a position from which it can take advantage of current and anticipated technology, maintaining its technological resources at a level compatible with public service and staff needs. The Technology Task Force recommends that:

1. The Library establish an Office of Technology which would: provide an overview of technological developments; coordinate department needs with overall library development; have referral information for questions beyond the scope of the office; supervise equipment maintenance procedures; keep abreast of campus and systemwide plans for telecommunications; play an advocacy role, along with other UC campuses, in bringing library needs to the attention of vendors and other organizations so that systems are developed with academic libraries in mind; arrange for trial use (e.g. Infotrac) of new systems. The office would be adequately staffed and funded to handle these tasks.

2. Patron and staff training be established as a priority. Currently: use of MELVYL, INFOTRAC and other systems should be taught to all public service personnel and appropriate student workers. Extra copies of journals and publications

pertinent to issues in automation, library applications for PC's, telecommunictaions, etc. should be made available to library personnel only, avoiding competition with patrons for high use materials. A technology training center would be the locus for the various patron and staff training activities. This center would house banks of micrcomputers, video monitors and other hardware and software training equipment needed. It would include a demonstration site for trial use of new equipment/systems for staff use to assist in purchasing decisions as well as staff education, including microcomputers for tutorials and new software perusal. A training coordinator would be necessary for scheduling, develop evaluation and training materials and procedures, etc.

Patron training should include videotape and interactive videodisc tutorials. Current production of videotapes for these purposes would not be wasted as they could be used in creating the interactive discs of the near future. The above staff training would help to keep patrons informed of new developments.

3. The Library acquire an interlinked online system within 5 years which would make available a public catalogue, circulation records, acquisitions, serials, ILL and cataloging accessible through a single terminal. Ideally the interlinked system would be remotely accessible to

campus and off-campus users.In 5 to 10 years, this system would be interconnected with a number of different information services including textual and numeric databases, and commercial searching services, using a user-friendly interface, accessed through scholar's workstations.

4. Current technology be maintained at a level consistent with public service demands. Included in current technology are present storage and access formats such as micromaterial equipment, copiers, printers, photocopy machines, audio and video tape recorders, projectors, monitors, etc. These methods of document storage and access will remain important even as new computer-assisted formats appear, as they will remain economical. An adequate number of trained personnel must be available during all hours of library service for keeping equipment in working order. User surveys indicate a general frustration in this area.

5. Future technology be maintained at a level consistent with public service demands. This will require new methods of upkeep and preservation tcehniques. The library should formulate plans and procedures for operation and maintenance of these systems before they arrive to achieve optimal service for patrons and staff alike.

6. "Scholar's workstations" become available in the library for patron use. The workstations would include microcomputers, video or CD Rom disc players, modems, printers, etc.. Certain functions may require a fee schedule, as in access to textual databases and electronic mail services. Copyright problems will certainly necessitate solutions in this area.

7. Disk technology be researched and acquired within 5 years. Optical laser disks, both analog video and digital CD ROM will be produced at en exponential rate. The library must plan for production of our own disks as well which would represent unique holdings, collections, patron training films, etc. Disks could be sold or traded among UC campuses or other institutions. Players for these disks must be researched for compatibility and standardization of format. Current uses might include serials indexes such as Infotrac.

8. The puchase of microcomputers be oriented towards use among the Library personnel on a large scale basis. This will encourage more creative uses and an increase in overall efficiency. Micromputers will replace typewriters as ubiquitous office tools. All PC's should have training tutorials, documentation, printers. They will be used for scheduling, interoffice communications, budgeting, draft

writing, analyses, cataloging of certain holdings, the creation of in-house public service tools, etc.

9. The Library should provide funds and time off for library personnel to develop in-house search aides and systems for some of our unique files, and to provide other integration strategies for reference tools and resources.